SensIT PI Meeting

Sri Kumar
DARPA/ITO
April 17-18, 2001
Tampa, Florida

Sensor Information Technology

Goal

Software for distributed Micro Sensor Networks

Thrusts

- New networking methods
- Leverage distributed computing paradigm for
  - Reliable extraction of right and timely information from sensor field
  - Networked signal and information processing
  - Dynamic querying and tasking

Algorithms and Software enabling cheap, smart, micro-sensors For Rapid, and Accurate Detection, Classification and Tracking

SensIT: Tasks

- Networking Fixed Sensor Devices
- Networking Fixed and Mobile Devices
- Querying/Tasking
- Collaborative Signal/Information Processing
- Integration and Experimentation – Lab, Field

Fixed Sensor Networking

- Ad-hoc, self-assembled
- Low-latency
- Survivability
- Power efficient
- Adaptive
- Size/Density

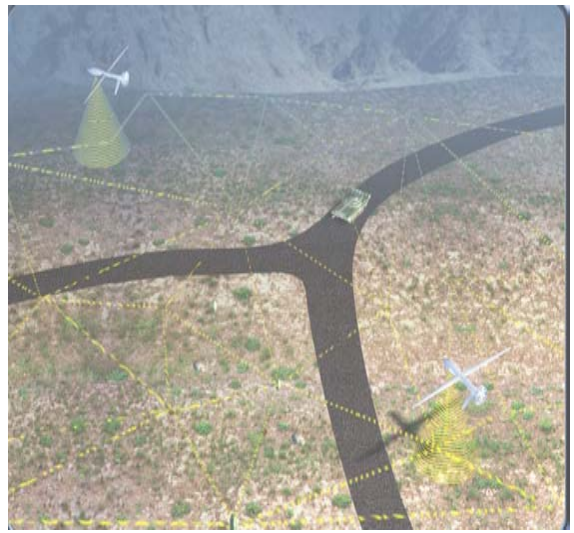
- Low Probability of Detect
- Secure

Fixed Mobile Internetworking

Demonstrate mobile query, sensing

Berkeley, Sanders: UAV
Rutgers: Protocols
Rockwell, Sensoria.Com: Radio
TBD: micro-robots

- **Develop New Protocols for Fixed/Mobile Internetworking**
  - **Varying Mobility**
  - **Intermittent Connectivity**



Querying and Tasking

- **Query and Tasking Language**
  - **Easy to use**
  - **GUI**
- **Distributed Micro-Databases**
  - **Enabling information extraction**
    - **Tracking, classification, ..**
    - **Depicting events of interest**
      - **Spatio-temporal**

Collaborative Signal and Information Processing

- Signal Processing, Fusion, Multi-mode
- Distributed Processing
  - Asynchronous
  - Efficient: Energy, BW, MIPs
- Recognizing events, scenarios
  - Space-time
  - Single, multiple vehicles
  - Convoys, Idling
  - Fork, Join….
  - Background noise..

- 12 scenarios CSIP group has developed
  - Technical challenges

  Solutions

  - Use of SITEX00 data
  - At Lab
  - In Field

- Broadband Data

FY 00, 01 Accomplishments

- **SensIT V.1.0 Software**

  Integrated, Experimental, Instrumented
  - **New Networking Protocols**
  - **Q/T Language and DB**
  - **Signal Processing**
    - **Single point detection; tracking**
  - **WIN CE**

- **SITEX 00**
  - **MAGCC, 29 Palms**
  - **Extensive Data Collection**
    - **Multi-Mode; For algorithm development**

- **SITEX 01 March 13-14, 2001**

SensIT Demonstration

SITEX01 13-14 Mar 01

Marine Corps Air Ground Combat Center
Twentynine Palms, CA

Autonomous, distributed ground sensors that track moving vehicles and transmit processed information to a base camp display

Ground Tracker Seismic
Rockwell/ISI/Virginia Tech
~ 1km//Base Camp

Fixed/Mobile
(UAV-Deployed Motes)
UC-Berkeley/MLB

Base Camp
~ 300 m//intersection

Tracker/Imager
BAE/Sensoria

SensIT storm brewing

- Strong Momentum
  - Various working groups
  - New CSP Group, Workshop at Xerox in Jan 01
  - Ongoing Integration
  - Energetic activity from all perfomers and working groups
- Strong Interest from Clients

ZensIT – Mindful Next Steps

- Demonstrate all NEW technologies of SensIT, and their superior performance over existing techniques
- Demonstrate new capabilities to DOD
  - Lab, Field (Nov)
- Clients knocking on door!!
  - It's here and now!

New Client-Opportunities

- Millennium Exercises
  - June 2002
- USMC Excercises
  - Steel Knight, Dec 2001
- Others
  - Air Force
  - Army
  - Navy

Thursday AM Agenda

09:00-10:00

SITEX 01 out brief (10 minutes each)

Theriault, BBN - overview

Kaiser/Reynolds Sensoria/BAE - Tracker/Imager

Schott/Chen, ISI/Rockwell, - Ground tracker

Pister, UCB - Fixed Mobile

Charlie Kiers, NSSW - Follow up

10:00-10:15

BREAK

10:15-12:15

Collaborative Processing session (20 minutes each)

Zhao, Xerox PARC - CoSense

Krishna, Duke/LSU - MU-FASHION

Beck/Reynolds, BAE - Sensor Agent Processing Software (SAPS)

Shaw, MIT/LL - Collaborative tracking

Brooks, Penn State - Reactive Sensor Networks

Blatt - BAE Sanders - Collaborative SP (15 min)

Oppenheim and Sostek - MIT (15 min)

12:15-01:30

LUNCH

Thursday PM Agenda

01:30-03:15

Networking session (20 minutes each)

Schott et al, UCS ISI/UCLA - Dynamic Sensor Networks

Estrin et al, USC - SCADDS

Hammel, Fantastic Data - Efficient Data Dissemination

Wicker, Cornell - Self-Configuring Wireless

Terry Fine, Cornell (10 mins)

Akbar Sayeed, CSP, Univ. Wisconsin (10 mins)

03:15-03:45

Platform Improvements

Wins, NG and OS – Kaiser/Merryl (20 mins)

Chien, Rockwell (10 mins)

03:45-04:00

BREAK

Thursday PM Agenda Contd..

04:00-05:30

User panel (Org: Dave Shepherd)

Army CECOM - Gayle Grant (Unattended Communications)

Special Operations - Erik Syvrud

USMC - Lt. Col. Dave Rababy (PM, RSTA)

Army - COL Kevin Peterson, USA (TRADOC System Manager - Prophet)

Air Force - Maj. Robert Bonneau (AFRL)

Continuous Demos/Poster at the other room

05:45-07:00

Reception

Friday AM Agenda

06:30-07:30

Breakfast

Speaker: **Roger Herdy Micro-craft** (07:00-07:15)

07:30-09:10

Query/Tasking, Sensor-ware session (20 mins each)

Ramanathan, Wisconsin - Location-Centric Computing

Subramanian, Maryland - Real Time Distributed Algorithms

Gehrke, Cornell - Flexible Decision Support

Lim, Auburn - Distributed Services

Phoha, Penn State - Semantic Information Fusion

09:10-09:25

BREAK

09:25-10:05

QTS Session Continued

Hawley, et al - Sensor-ware

Biagioni, Hawaii - Remote Ecological Micro-Sensors

Friday AM Contd..

10:05-10:50

Fundamentals (15 mins each)

Bruce Hajek, Amorphous Networking

Abelson/Sussman et al - Amorphous array computing

Sastry, Shankar, Issues in Distributed Sensor Networks

10:50-11:00

BREAK

11:00-12:15

Networking: Fixed/Mobile (15 mins each)

Pister, UC Berkeley - Sensor Webs of Smart Dust

Badrinath, Rutgers - WebDust

Chien, Rockwell - Distributed Services for Microsensors

Signal, Image, Video Processing (10 mins each)

Yao, UCLA - Signal Processing

Katsaggelos, NWU - Video processing

Gharavi, NIST - Video/Image processing

Friday PM

12:15-01:45

LUNCH

Keynote Speaker: Col. Chris Shepherd, USJFCOM

01:45-03:00

SITEX 02 and Integration Discussion (BBN)

Session 1: Integration (30 mins)

Session 2: SITEX02 (45 mins)

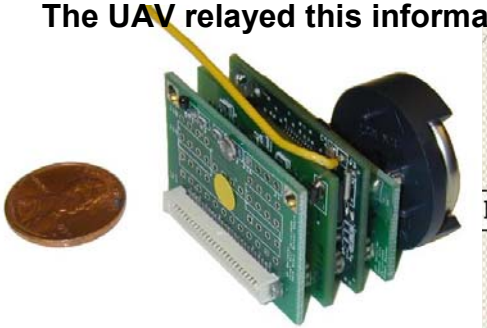
03:00-03:15

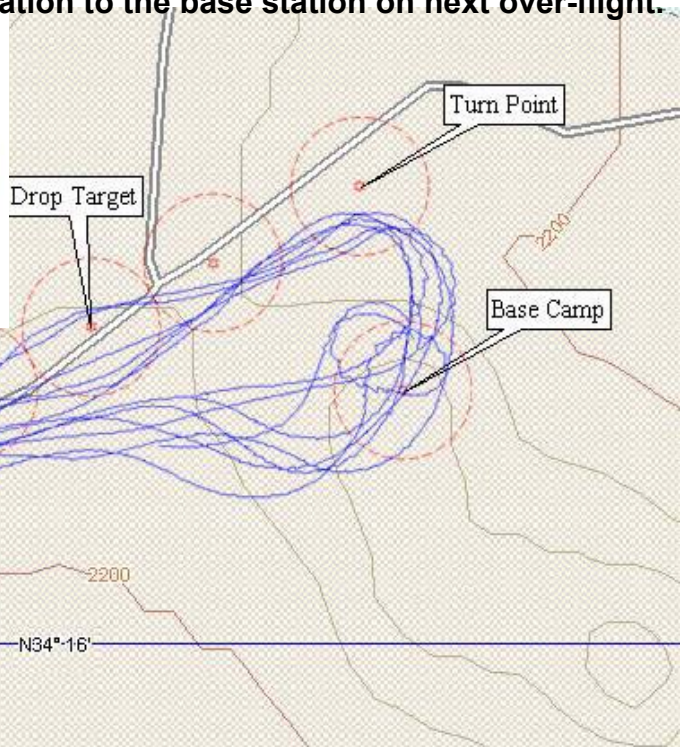
Wrap up and Vote of Thanks

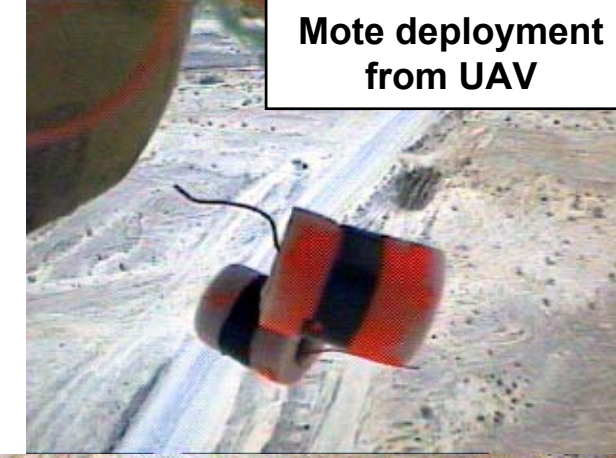
Back Up

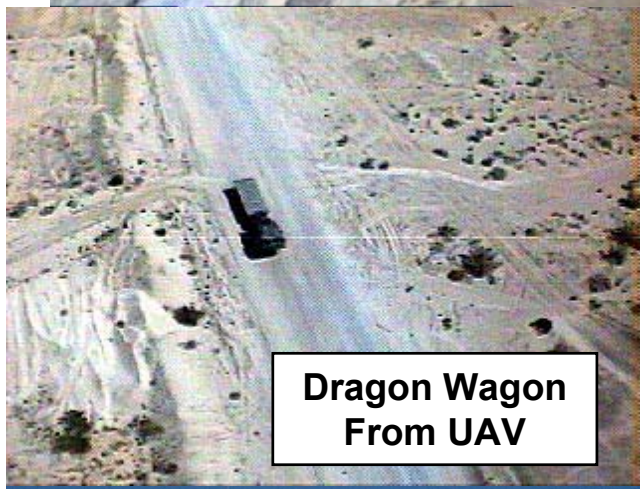
SITEX01: Vehicle tracking with a UAV deployed network: UC Berkeley

- **6 wireless sensor nodes were dropped from a 5' UAV, landed at 5 meter intervals, established a multi-hop network, and synchronized clocks.**
- **Passing vehicles caused a change in the local magnetic field. The motes sample their 2 axis magnetometers at 5 Hz, filter and threshold the data, and transmit a time-stamped message to the rest of the network when a vehicle is detected.**
- **A least-squares estimate of vehicle velocity was calculated and stored by every mote for every vehicle, and motes update their estimated position assuming constant velocity vehicles.**
- **Whenever the UAV returned, the network transmitted the vehicle track info.**
- **The UAV relayed this information to the base station on next over-flight.**









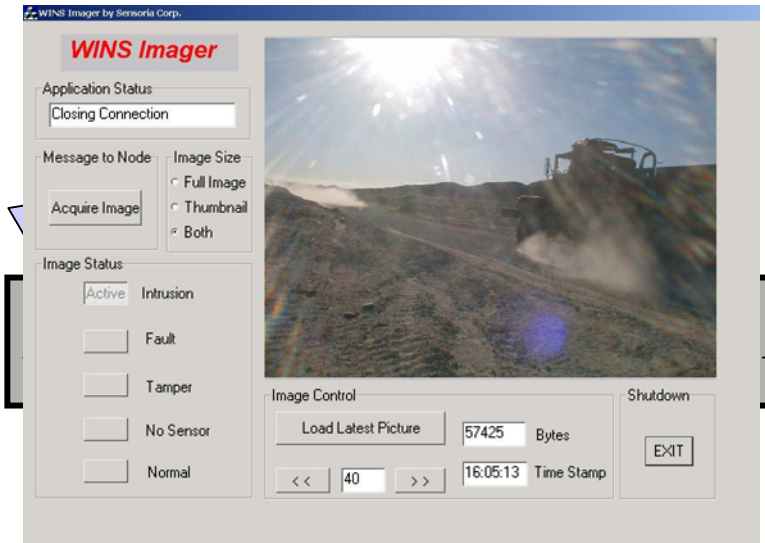
SITEX01: Imager/Tracker Demo
Sensoria/BAE

March 13-14, 2001
MCAGCC
29 Palms, CA

DARPA

Demonstration

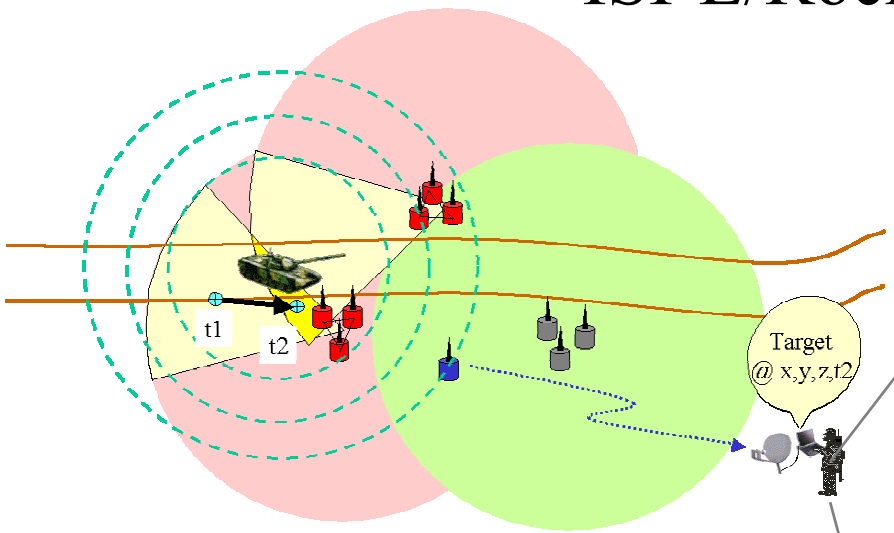
- Track a vehicle as it drives east to west down the road.
- Update the tracker estimates of vehicle speed and location.
- Take a picture when the vehicle is in the image field of view.
- Requires coordination between nodes at all levels from tracking to message passing



Road West of Intersection

West

SITEX01:Sensorware and Tracker ISI-E/Rockwell

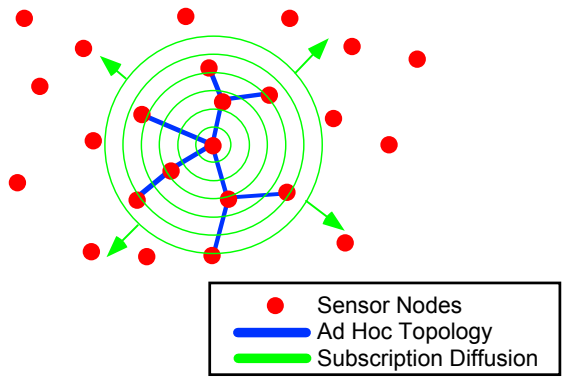


- At Base Camp
  - Situation status display GUI (running on laptop).
  - Live video feed at 5fps on wireless iPAQ PDA.

- Wave Intensity Comparison –multiple projections are made from seismic signal energy at sensor node clusters.
  - Nine Rockwell HYDRA nodes.
  - Laptop with web cam.
  - COTS 802.11 wireless Ethernet bridge to base camp (~1km).

Fixed Sensor Network Protocols

- **Protocol 2: Declarative Routing (MIT/LL)**
  - Nodes publish data/activity
  - Processes at other nodes subscribe
  - Connectivity through interests
  - Multi-Tasking: information fusion across tasks



- **Protocol 3: IP (Sensoria.Com)**
  - For baseline comparison

Next Focus (Fixed Networks):

- **Extend Protocols: Gradients, Multi-cast, In-Cast**
- **Performance Evaluation: Theory, Lab/Field (ISI, Cornell, BBN)**
  - Some Preliminary Simulation Results (FY00)